

Air, Nitrox or Trimix Manage your pO_2

From the Basic Nitrox levels through to advanced Trimix, we base our calculations of dive profiles on a specific partial pressure of oxygen— pO_2 . Managing and controlling the pO_2 lies at the foundation of any level of technical diving as it enables us to perform longer, deeper and safer dives compared to diving air. But there are also a few points to watch.

We are all aware that as we descend the gas in our lungs and body tissues compress and becomes denser. The deeper we go and longer we stay, the more of the inert gas Nitrogen (and in the case of diving with trimix, also helium) our tissues will absorb and hold. Oxygen on the other hand is utilized in the metabolism, with carbon dioxide (CO_2) being a resulting waste product. So, first of all, while diving deep and breathing gasses with elevated pO_2 , we want to keep our levels of exertion down as much as possible and metabolism and CO_2 production down. As work load increases, levels of CO_2 could

reach dangerous levels as it leaves divers more prone to oxygen toxicity and nitrogen narcosis. (As well as giving you a very undesirable headache.)

Weighing pros and cons

Breathing any gas at elevated partial pressures comes with both advantages and risks. The most obvious advantage is when you increase the pO_2 and conversely lower your pN_2 (partial pressure of Nitrogen) you reduce nitrogen absorption, and with it, all the issues around decompression. As every Basic Nitrox diver will know, even modest increases in oxygen content can lead to significant longer no-decompression limits.

On the other hand, each individual gas may cause, in some cases similar, in other cases very different, potentially dangerous symptoms that could lead to the diver failing to return to the surface.

Know the partial pressures

That is, if we don't know how to manage the partial pressures our breathing gases. Using Dalton's law, we can exactly calculate the partial pressures of oxygen, nitrogen and helium at any depth. We can thus also calculate our dosage of these gases.

And nitrogen isn't the only gas that can cause a problem when you breathe it for longer times at elevated pressure. Oxygen toxicity is, for one, another issue we need to get a grip on when venturing into any sort of technical diving.

Breathing oxygen at elevated partial pressures for an extended time can be toxic and lead to confusion and loss of muscle control, and ultimately seizures and convulsions, which under water will most likely result in drowning.

Limits

The NOAA time limit for a single exposure to a pO_2 of 1.6 bar is 45 min. For a pO_2 of 1.3 bar the limit is at a somewhat more comfortable 180 mins. NOAA is the National Oceanographic Atmospheric Administration in the US. Based on their studies, all training agencies state the absolute maximum PO_2 breathed during a dive should not exceed 1.6 at any stage, with 1.4 being the recommended max PO_2 for the bottom phase.

Personal limits

The exact PO_2 or point where O_2 has a toxic affect on the central nervous system will vary greatly from individual to individual, as well as an individual from day to day, or from dive to dive.

If the type of environment, equipment, mission or task changes from dive to dive, exertion levels could also change, hence, altering and perhaps increasing the amount of O_2 metabolized. It is unfortunately not possible to calculate and establish the exact amount of O_2 metabolized considering all these variables. So, if you think you may be exerting more than normal on a

specific dive, chose to breathe a lower pO_2 if you have the option. I would recommend lower than 1.3 bar during dives with a heavier work load.

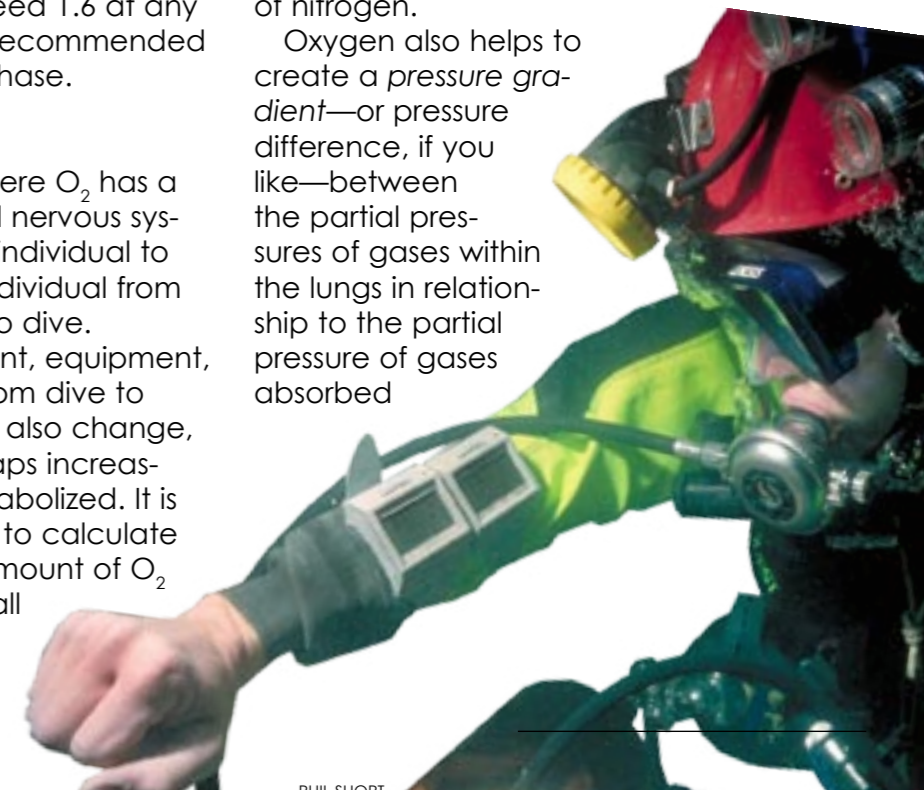
NOAA have also established the fact that a time limit at specific pO_2 's is another factor that must be taken into consideration; The higher the pO_2 , the shorter the time limit would be before O_2 has a toxic effect.

Oxygen is our friend

So, let's try to put things into perspective and recap. Oxygen is good, it's our friend. The higher the oxygen content in a nitrox mix, the smaller the proportion is of nitrogen.

Oxygen also helps to create a *pressure gradient*—or pressure difference, if you like—between the partial pressures of gases within the lungs in relationship to the partial pressure of gases absorbed

I survived the earlier stages of my diving career due to one reason - "luck".



PETER SYMES

PHIL SHORT

technical matters



within the tissues. It is this pressure difference that forces the inert gases to move out of the tissue – we term this *inert gas elimination*. The inert gasses are N₂ and He and culprits behind decompression related problems such as the bends (aka DSC or DCI). The less inert gas in the mix, the less inert gas gets absorbed in the tissue, giving us the option to extend bottom time or to just take advantage of the extra safety less absorption of inert gas is giving us.

But...

If limits—pressure or time, or a combination of both—are exceeded, oxygen will be less forgiving than nitrogen or helium. Nitrogen Narcosis and High Pressure Nervous Syndrome (HPNS) the effect of Helium on the body under high pressure) do not lead to drowning or embolism as a bad hit of oxygen toxicity could.

However, as long as the oxygen dose (pO₂) and time limits are not exceeded and we have good general diving technique (low levels of exertion), it's highly unlikely we would experience

oxygen toxicity-related problems.

Having said that, NOAA did once succeed—with the help of the US Navy and in a dry chamber—to induce an oxygen seizure in a human subject at a pO₂ of 1.3. This is the lowest inspired pO₂ on record

that a oxygen seizure has been induced. Having said that, the dude in the chamber was over-exerting to an extreme degree during the experiment. But even so, the experiment clearly emphasized the necessity for low exertion levels while breathing elevated pO₂'s during a dive.

And don't forget...

So it seems oxygen is the primary gas we need to keep within recommended limits.

But the wise diver should not forget and overlook the potential hazards related to nitrogen narcosis while focusing on issues with oxygen. In my experience in deep diving, I've seen many more divers having serious problems with nitrogen narcosis rather than oxygen toxicity. Recreational training agencies have put a depth limit on air diving to max 40m. This was established due to the fact that most divers (without specific deep water technical training) begin to act irrational beyond this depth, putting themselves and possibly other divers at risk, combined with the fact that the NDL becomes impractically short.

Don't push it

Traditionally, the mix that divers sometimes push depth limits with is air! Few divers with any sort of technical training would consider pushing beyond the recommended depth with an enriched air/nitrox mixture due to the increased risk of oxygen toxicity. However, I've met many a recreational diver happy to push past 40 meters without specific deep diver training with air—in some cases, well beyond 60 meters. Although the pO₂ of air does not exceed NOAA recommendations until we reach 66 meters, divers should take the effects of nitrogen narcosis seriously, or risk ending up as a statistic.

HPNS

For the tec diver using trimix, the gas toxicity story becomes much more complicated by adding a third gas, helium, which has it's own list of potentially dangerous symptoms when the helium content is high and the descent was very fast. It is not something that the mix diver needs to consider in the first 100m. But for the more experienced mix diver pushing past 100m, the effects of HPNS (High Pressure Nervous Syndrome) could become an issue. Symptoms include vomiting, diarrhea, micro sleep and probably the most common "tremors", normally starting in the arms below the elbow. A slower rate of compression (descent rate) will reduce the severity of the tremor, but obviously a too slow descent will increase decompression time and overall gas needed.

Some deep mix divers choose to increase the nitrogen content below 100m, as nitrogen tend to act as a buffer, reducing the severity of the tremor. A sensible balance in this case is the key. Shaking around at depth is definitely something we would like to avoid but not to the point where clear logical thought processes and problem solving gets impaired due to too high nitrogen dose! ■

Leigh Cunningham is the technical manager and TDI Instructor Trainer for Ocean College, Sharm El Sheikh. Probably best known for his records - Leigh once held the record for the deepest dive in the Red Sea, and is the current holder of the record for deepest wreck dive - and attempts of reaching extreme depths, he also has a wide range of teaching credentials to his curriculum: TDI instructor trainer, DSAT Tech Trimix instructor, PADI MSDT IANTD Technical diver instructor CMAS 3 star instructor

Supporting a record 870 poverty-fighting projects in 70 countries, reaching more than 45 million people



overland-underwater.com

Dear Friends

Across the globe more and more people's lives are directly improved by the activities of projects run by CARE International, whose aim is to serve individuals and families in the poorest communities through out the world.

To help raise awareness of this important work undertaken by CARE International, the overland-underwater team is going to drive from the United Kingdom to New Zealand by the most overland route possible. It is our intention to raise a substantial sum via donations, pledges and sponsorship for CARE International.

We will be covering 65,000 km, visiting 26 countries across 4 continents, facing temperature extremes of 40°C in the deserts of the Middle East to -20°C as we cross the Himalayas and will be driving over rock, sand, mud, snow and the occasional bit of tarmac!

The expedition is in aid of CARE International with the entire costs of the trip being funded by the team.



We are due to leave the UK at the beginning of August 2005 and will arrive in New Zealand 18 months later. We want to raise the profile of CARE International and will be visiting some of their projects along the route.

Please visit our website www.overland-underwater.com for further expedition details and progress updates as we travel to New Zealand. You can make donations securely online via the link from our website, or download a pledge/sponsorship form and post with your donation to CARE International.

ROUTE:

UK - FRANCE - ITALY - SLOVENIA - CROATIA - SERBIA & MONT - BULGARIA - TURKEY - SYRIA - JORDAN - EGYPT - IRAN - PAKISTAN - INDIA - NEPAL - CHINA - LAOS - THAILAND - PHILIPPINES - CAMBODIA - MALAYSIA - SINGAPORE - INDONESIA - PAPUA NEW GUINEA - AUSTRALIA - NEW ZEALAND

For further information, please see our website: www.overland-underwater.com
Alternatively you can email us at: team@overland-underwater.com

Manage your pO₂

